Natural Occurrence of Tomato Viruses in Azerbaijan

N.F. Sultanova, S.T. Mirzayeva, N.K. Bayramova, I.M. Huseynova*

*Bioadaptation Laboratory, Institute of Molecular Biology & Biotechnologies, Azerbaijan National Academy of Sciences, 2A Matbuat Ave., Baku AZ 1073, Azerbaijan; *E-mail: i_guseinova@mail.ru*

During growing season of 2015-2017 (June-September), phytopathological surveys were conducted in the southern part of Azerbaijan. A total 263 suspicious tomato (*Solanum lycopersicum* L.) samples of various cultivars exhibiting symptoms of leaf curl, dwarfing, leaf narrowing, necrosis, mosaics or yellowing with reduced fruit yield and quality were collected in three regions (Jalilabad, Masally, Lankaran) of Azerbaijan. Collected samples were first tested serologically (rapid one-step assay AgriStrip, DAS-ELISA) depending on virus symptoms and then molecular tests (RT-PCR, PCR) were performed to confirm the virus presence. According to the result of serological tests, 179 samples (68%) positively reacted with the virus antibodies. DNA and RNA genome virus infections were confirmed by polymerase chain reaction (PCR) and reverse - polymerase chain reaction (RT-PCR). Results showed the presence of *Tomato mosaic virus* (T_oMV), *Tobacco mosaic virus* (TMV), *Tomato etech virus* (TEV), *Tomato spotted wilt virus* (TSWV) and *Cucumber mosaic virus* (CMV) in tomato samples. CMV was the most common virus, infecting about 25% of the tomato samples. TMV and ToMV, infected tomato samples by about 21% and 13%, respectively, followed CMV in frequency. This study reports the natural incidence and prevalence of tomato viruses in the southern part of Azerbaijan.

Keywords: *Solanum lycopersicum* L., virus diseases, *tomato mosaic virus*, *tobacco mosaic virus*, *tomato etech virus, tomato spotted wilt virus, cucumber mosaic virus*

INTRODUCTION

Agriculture still stands in the first place for most Azerbaijani people, despite the fact that the share of industry is constantly growing. It should also be noted that vegetable growing occupies an economically important place in Azerbaijan. The total volume of vegetable production in Azerbaijan for a year is about 1.72 million tons. Vegetable crops are frequently affected by a wide range of diseases showing varying degree and kind of symptoms. Most of the causal agents of the diseases are biotic, not ruling out the involvement of abiotic factors too. Among the biotic factors, virus diseases constitute a bulk of the diseases observed in all plant types, with variable symptoms including leaf curling and distortion, green or yellow foliar mosaic, stunting of plants, and reduced yields (Rakhshandehroo et al., 2011). Plant diseases caused by viruses can be devastating on crops leading the yield reduction. At present, one of the leading vegetables in the country is tomato wihch is mainly produced in the southern regions of Azerbaijan, such as Masally, Jalilabad and Lankaran. Tomato has a particular importance to meet the demand of the population for food. According to the State Statistics Committee, 27,400 hectares of tomatoes are grown in our country and productivity of tomato is 463,200 tons. Several viruses, such as, *Cucumber mosaic virus* (CMV), *Tomato yellow leaf curl virus* (TYLCV), *Pepper mild mottle virus* (PMMoV), *Tomato mosaic virus* (TMV), *Tobacco mosaic virus* (ToMV), *Tomato spotted wilt virus* (TSWV) on tomato and/or pepper crops, as well as CMV, *Zucchini yellow mosaic virus* (ZYMV), *Squash mosaic virus* (SqMV), *Watermelon mosaic virus* (WMV) in cucurbits have been reported to occur over the past decade in different regions of Azerbaijan (Huseynova et al. 2016; Huseynova et al., 2017; Verdin et al., 2018; Desbiez et al., 2018), and some of them have capacities to cause epidemics and significant yield losses to these crops, e.g., TYLCV (Moriones and Navas-Castillo, 2000).

The rapid increase in viral diseases in the modern world poses a serious problem for food security. Especially in plants of agricultural importance, viruses that cause disease are very dangerous and cause serious economic losses. The diagnosis, identification of pathogens and certification of seedlings have great importance for the timely prevention of viral diseases. Therefore, plant protection from pathogens is not only an economically important problem, but also one of the most important areas of modern scientific research. The issue of providing the population with eco friendly agricultural products has always been in the focus of our government's attention and is reflected in the most government programs. In recent years, the international exchange of seedlings has led to the spread of viral diseases in large regions. This is

becoming increasingly dangerous for tomato that is sensitive to viral diseases (Hanssen et al., 2012). Thus, the economic damage caused by various DNA and RNA genome viruses of tomato increases every year and is calculated in millions of manats. It is known that with severe infections, a higher loss of product is observed. From this point of view, it is important to study virus diseases of tomato and take preventive measures against them. The choice of struggling methods against them requires the initial diagnosis of pathogens, taxonomic characteristics, identification of the pathogenic spectrum of plants and insect vectors (Xu et al., 2017).

Therefore, the purpose of the research was to investigate the occurrence frequency and distribution of the main tomato viruses in tomato growing areas of Azerbaijan.

MATERIALS AND METHODS

Surveys and plant sampling. In order to identify viruses infecting tomato and evaluate the prevalence of viral infections, three surveys were conducted during June-July months of 2015, 2016 and 2017 growing seasons in important tomato areas of the southern part of Azerbaijan including Jalilabad, Masally and Lankaran (Figure 1). Total 12 fields were surveyed and 263 samples were collected from symptomatic plants as well as from non-symptomatic and healthy plants. Two non-cultivated (weed species) plants, showing TMV like symptoms were also collected around fields surveyed. Collected samples included young and fresh leaves and fruits of tomatoes with various symptoms. The plant material was transported to the laboratory on ice, immediately placed in plastic bags and kept at 4°C until they were processed. For long-term storage, leaf samples were stored at -80 ºC.

Detection and identification of viruses. Enzyme-linked immunosorbent assay (ELISA) and Polymerase chain reaction (PCR) which are the most common and widely used techniques for routine screening of pathogens were used for virus detection and identification.

Serological assays. Initially, rapid one-step assay AgriStrip which based on lateral flow immunochromatography and manufactured by Bioreba (Reinach, Switzerland) was performed to confirm the presence of TMV, T_oMV, CMV, TSWV in samples depending on suspicious virus symptoms. Midribs (area of the blade with primary veins) from basal (mature) and apical (young) leaf blades and petioles from infected tomato samples were analyzed. After the sample was homogenized a few drops of homogenate were transferred to a new cuvette. The strip was immersed into the extract, and the result was read within a couple of minutes. The positive result was considered as a color band on the test line, while the colored band on the control line always appeared.

Midrib and leaf petioles from symptomless tomatoes as well as from tomato with virus-like symptoms were also tested for TMV, T_oMV, CMV, TSWV, TYLCV, TEV, TRSV, AMV, BCTV by TAS-ELSA and DAS-ELISA using the ELISA kits developed by Bioreba AG (Reinach, Switzerland) and Agdia (USA) according to the manufacturer's instructions. All chemicals and buffers used in this assay, as well as negative and positive controls for each virus were provided by the company. Briefly, ELISA plates were coated with 200 µl of IgG (1:1000 dilution) diluted in carbonate coating buffer and incubated for 3 hours at 37ºC. Before 200 µl leaf extracts were added to the each well, plate was washed with washing buffer and incubated overnight at 4ºC. Then the plates were washed again and 200 µl of alkaline phosphatase-conjugated IgG diluted in conjugate buffer (1:1000) was added and incubated for 3 hours at 37ºC. After washing the ELISA plates were incubated with 200 µl of substrate (1 mg/ml of p-nitrophenyl phosphate in substrate buffer) at room temperature. Color reactions were measured at 405 nm (A405) after 2 h, using ELISA microplate reader (Stat Fax Microplate, Awareness Technology, USA). Each sample was analyzed in two wells, and samples were considered positive if the A405 nm values were more than three times those of the healthy control.

Molecular analysis. To confirm the presence of DNA and RNA genome viruses, leaf samples with a positive reaction in the serological assays with the virus were tested by PCR, RT-PCR methods using universal primers and primer pairs designed for the specific detection of the virus (Table 2). Total RNA was extracted from the leaf tissues using Trizol reagent (Invitrogen, USA) according to the manufacturer's instructions. Approximately 50-100 mg of fresh leaf tissue were placed in a sterile mortar and homogenized with 500 µl of grinding buffer (TRI-reagent). Aliquots of 500 µl of the extract were mixed with 100 µl of chloroform in a new set of sterile microfuge tubes and centrifuged at 13,500 rpm with refrigerated centrifuge for 15 min. Then, 300 µl of the supernatant were transferred to a new eppendorf tube containing 250 µl isopropanol and after shaking gently the tubes were kept for 15 min at room temperature. After centrifugation at 13,500 rpm for 20 min the supernatant was discarded and the pellet washed twice with 75% ethanol and dried at room temperature. The pellet was resuspended with 150 µl of RNase-free water and stored at –80°C until use. For TYLCV detection total DNAs were extracted from 1 g fresh leaf midribs of infected and

healthy plants (as control) following CTAB extraction protocol (Maixner et al., 1995). Purity degree and concentration of extracted DNA and RNA samples were determined spectro-photometrically (Ultrospec 3300 PRO, Amersham, USA). Then the RNA and DNA samples were analysed with RT-PCR and PCR. RT-PCR was performed in the reaction mix containing 4 µl of RNA, 1.5 µl of virus universal or specific primers, 1.5 µl of dNTPs (25 mM), 4 µl of RT (5x) buffer, 1 µl of M-MLV (RT enzyme), 8 µl of ddH2O. The reaction was carried out for 1 h at 42ºC. In order to stop the reaction, the samples were kept at 65ºC for 10 min. After the electrophoretic analysis, RT-PCR products were tested using PCR method. Amplification was carried out in a thermocycler (Multigene Gradient, "Labnet"company, USA) after preliminary denaturation at 95°C for 2 min, followed by 35 cycles at 94°C for 1 min, annealing for 45 s and extention at 70°C for 50 s, and a final extension at 72°C for 10 min. Following PCR, 10 µl of the product was electrophoresed on a 1% and 1.5% agarose gel, stained with ethidium bromide and recorded digitally using UV-Gel Doc system (UK).

RESULTS AND DISCUSSION

Identification and distribution of tomato viruses. We analyzed 263 tomato samples taken from commercial fields in three regions of the southern part of Azerbaijan (Figure 1). Samples were collected from 12 fields randomly selected in each geographical area surveyed. Selected fields were separated by about three km in the each surveyed areas. Each field was examined and sampled once in a year at the middle growth stage of the plants.

During these surveys, virus-like symptoms, including formation of yellowish and mosaic-red spots, in some cases rolling leaves, mottling, chlorosis, dwarfing, leaf deformation and roughness, necrotic spots on the leaves, reduced leaf size, boat shaped leaves, reduced fruit bearing and quality were frequently observed in tomato fields (Figure 2).

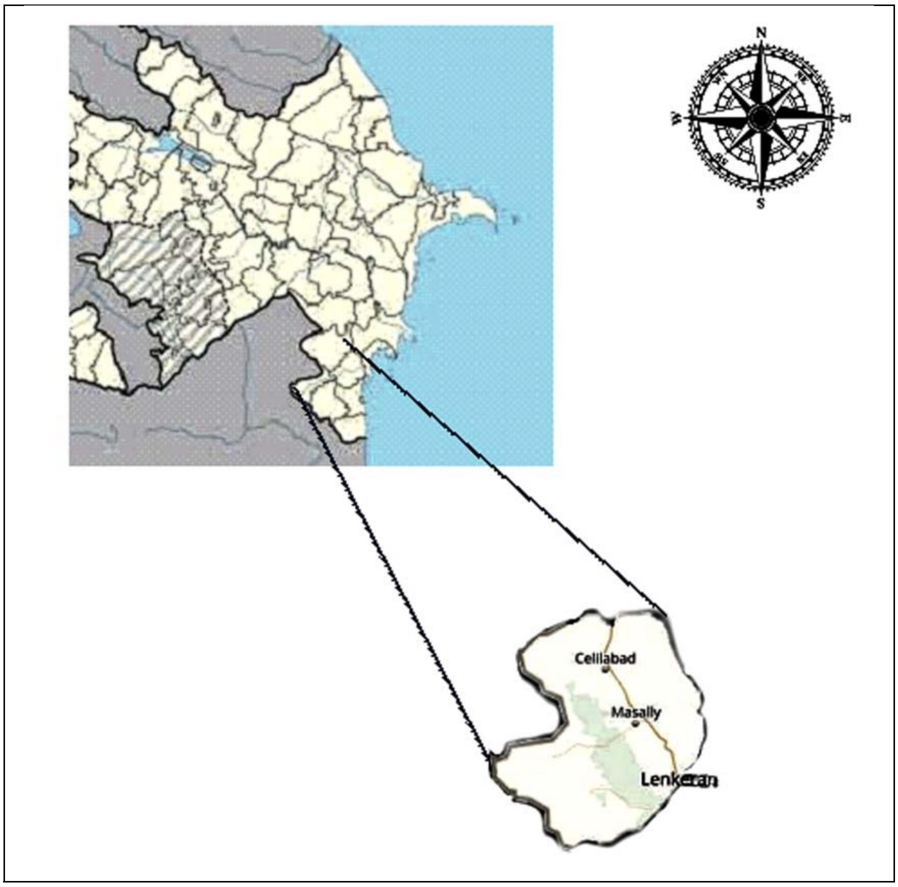


Fig. 1. Map of Southern part of Azerbaijan showing regions in which surveys were conducted during the 2015-2017 growing seasons.

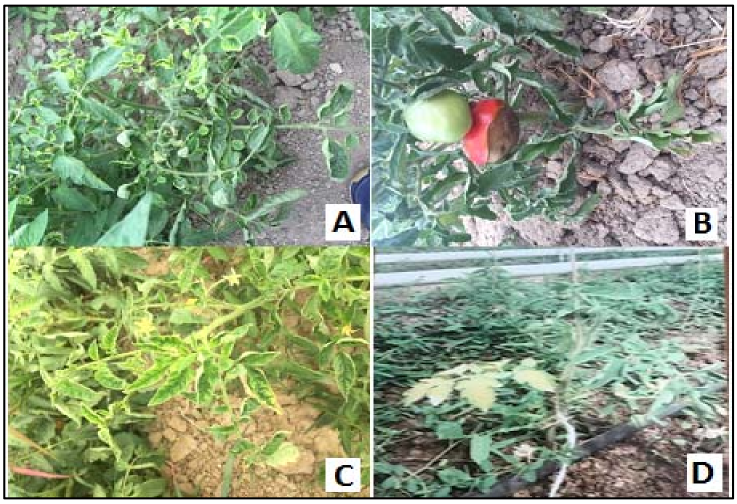


Fig. 2. Reduced leaf size and formation of boat shaped leaves (A), reduced fruit bearing and quality (B), mosaic and rolling of leaves (C), chlorosis and leaf deformation (D) symptoms associated with the virus infection on tomato.

Table 1. Incidence of nine* viruses in tomato plants collected in the southern regions of Azerbaijan.

Region of sampling	Year of sampling	No. of samples	TMV	TEV	TYLCV	ToMV	CMV	TSWV
	2015	36	6	0	0	9	12	0
Calilabad	2016	32	4	0	0	6	10	0
	2017	28	2	0	0	2	8	0
	2015	34	3	0	0	11	9	0
Lankaran	2016	20	2	0	0	8	5	0
	2017	12	0	0	0	3	2	0
	2015	48	8	3	4	6	9	8
Masally	2016	34	6	2	2	5	6	5
	2017	19	3	0	0	4	4	2
Total	2015-2017	263	34	5	6	54	65	15

*TRSV, AMV, BCTV were tested in tomato samples, but not detected in any of the samples tested.

During the surveys (2015, 2016 and 2017), TMV, ToMV, CMV, TSWV, TYLCV, TEV, TRSV, AMV, BCTV were analyzed in all tomato species by serological methods. TMV, ToMV and CMV were detected in all the regions, whereas TSWV, TEV and TYLCV were detected only in Masally (Figure 1 and Table 1). We failed to detect TRSV, AMV and BCTV in any of the samples tested. During the three-year survey, almost 68% of tested plants were infected by at least one of the viruses. In 2015, laboratory testing of 118 collected tomato samples indicated that the incidence of viral infection overall was 74.6%, eighty-eight out of 118 (Table 1). In 2016, laboratory testing of the 86 collected tomato samples indicated that the incidence of viral infection overall was 71%, sixty-one out of 86. CMV was the most common virus, infecting about 25% of the tomato samples. TMV and ToMV, infected tomato samples by about 21% and 13%, respectively, followed CMV in frequency (Table 2). The viruses TEV and TYLCV were detected in less than 2%, 2.5% of all samples, respectively. TSWV was followed in frequency by TMV and ToMV, which infected about 6% (15 out of 263) of the tomato samples (Table 1). During the surveys, the proportion of plants with symptoms of leaf chlorosis was visually estimated for each field. These observations, together with the analysis of the detected viruses in the tomato samples, gave an estimate of the frequency of CMV in the study areas. In 64% of the fields, the incidence of CMV was greater than 22%. The presence of CMV was also estimated in the weed hosts as natural sources of plant viruses. The incidence of tomato virus in weed hosts was recorded in Masally (22.2 %) and Jalilabad (10.4 %). Other tomato viruses were not detected in weeds.

Samples that were positive (TMV, ToMV, CMV, TSWV, TYLCV and TEV) according to ELISA results were checked by RT-PCR and PCR to confirm the presence of viruses and to identify them. The PCR and RT-PCR tests using the universal or specific primer pairs (Table 2) resulted in the amplification of one DNA product of approximately 320, 422, 529, 276 and 500 bp in size for ELISA-positive samples tested from tomato plants (Figure 3).

Table 2. List of primers used in this study.

Primers	Sequences (5'-3')	Reference
CMV1 CMV2	5'-GCCGTAAGCTGGATGGACAA-3' (5'-TATGATAAGAAGCTTGTTTCGCG-3')	Zitikaite I. et al., 2011
TMV-2 TMV1	5'-GAAAGCGGACAGAAACCCGCTG-3' 5'-GACCTGACAAAAATGGAGAAGATCT-3'	Silva R.M. et al., 2008
ToMV-6 ToMV-5	5'-GATCTGTCAAAGTCTGAGAAACTTC-3' 5'-CTCCATCGTTCACACTCGTTACT-3'	Silva R.M. et al., 2008
Tobamo-1 Tobamo-2	5`-CGAGAGGGGCAACAAACAT-3` 5`- ACCTGTCTCCATCTCTTTGG-3`	Kumar S. et al., 2011
TY-1 TY-2	5`-GCCCATGTA(T/C)CG(A/G)AAGCC-3` 5`-GG(A/G)TTAGA(A/G)GCATG(A/C)GTAC-3`	Accotto G.P. et al., 2000
MA13 F MA26 R	(5`-AATGCAATCTTCGTCACC-3`) (5`-CGCCCGTCTCGAAGGTTCG-3`)	Chinnaraja C. et al., 2016
L1 TSWV R L2 TSWV F	5`-ATC AGT CGA AAT GGT CGG CA-3` 5`-ATC AGT CGAAAT GGT CGG CA-3`	Milosovic S. et al., 2011
TEV-Poly2_F TEV-Poly2_R	5`-GTGTGCAAAGAAATTCCAGACTC-3` 5`-CACCACCAATTAACACAGACAAAG-3`	Lee J. et al., 2011
AMV1-F AMV1-R	5`-CCATCARGAGTTCTTCACAAAAG-3` 5`-TCGTCACGTCATCAGTGAGAC-3`	Al-Abrahim J.S. et al., 2014
TRSV F TRSV R	5`-CTTGCGGCCCAAATCTATAA-3` 5`-ACTTGTCCCAGGAGAGCTA-3`	Sneideris D. et al., 2012
BCTV-C1 2387R BCTV-C1 2097F	5`-TGCTCCAATAAGGTGCTTCCAGTG -3` 5`- TTTCCTCTGTCCTCATTCACAAACG-3`	Almasi M.A. et al., 2013

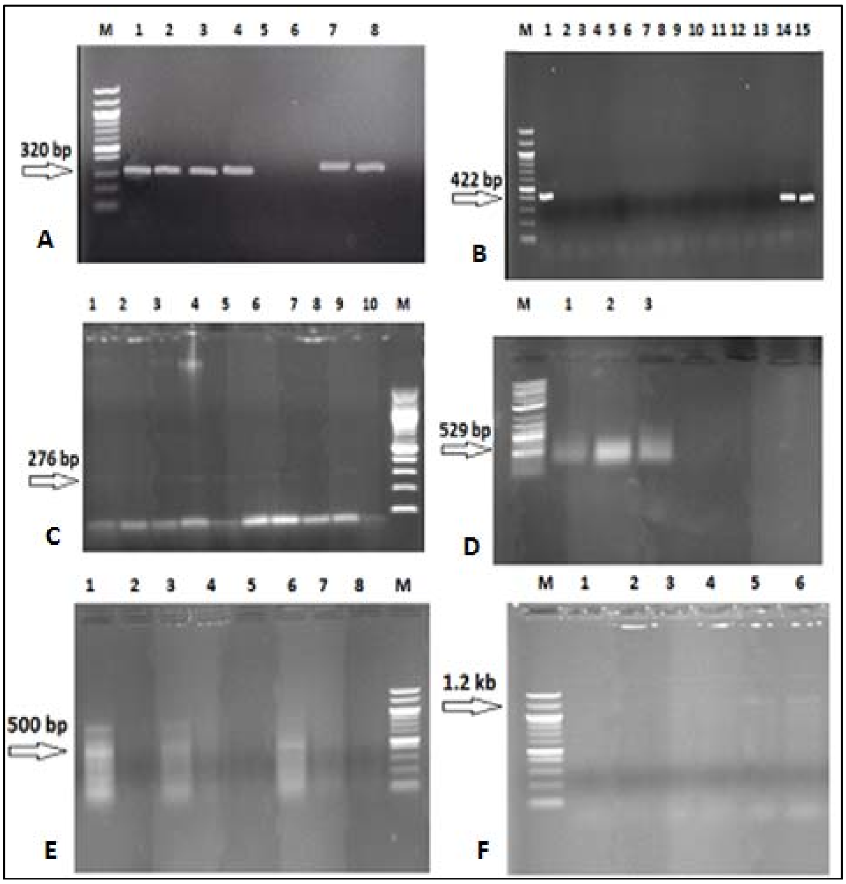


Fig. 3. RT-PCR and PCR analysis with universal (A) and specific primers of CP gene (B,C,D,E and F) of the tomato viruses. M-1kb and 100 bp DNA ladder. 1- 15 different tomato samples.

Obtained results confirmed the presence of ToMV, TMV, TEV, TSWV and CMV in tomato samples. No DNA product from healthy plant extracts was amplified. RT-PCR and PCR results confirmed that these tomato viruses occurred in all tested species and in regions surveyed. There was no mixed infection in collected tomato samples in the above-mentioned regions.

The expected fragments of approximately 320 bp (Kumar et al., 2011) were amplified by PCR from

total RNAs extracted from 88 ELISA-positive samples using the universal primers tobamo 1 and tobamo 2 (Figure 3A). The results of RT-PCR and PCR analyses confirmed the presence of tobamoviruses (TMV and ToMV) in samples of tomato. However, amplicons were not obtained from the other ELISA-negative samples. The DNAs extracted from this samples were subsequently tested by RT-PCR using the tobamovirus specific primers (TMV1 and TMV2; ToMV-5 and ToMV-6); an amplicon with the expected size of 422 bp (Silva et al., 2008) was obtained for tomato samples tested, showing severe yellowing and leaf deformation symptoms (Figure 3B). One DNA amplification product of approximately 276 bp or of 529 bp was observed in samples that were positive for TSWV or TEV, respectively, in DAS-ELISA (Figure 3 C,D). The expected fragments of approximately 500 bp (Zitikaite et al., 2011) were amplified by PCR from total RNAs extracted from 65 ELISA-positive samples using the spesific primers CMV 1 and CMV 2 (Figure 3E). Thus, the results of RT-PCR and PCR analyses confirmed the presence of tobamoviruses (TMV and ToMV) in samples of tomato. The primers used in this study, the sequences and reference data for ech primer are shown in Table 2. To confirm the presence of TYLCV infection, PCR was carried out with geminivirus specific primers, such as MA13/MA26 primers targeting 1292 bp of circular DNA-A of TYLCV (Chinnaraja et al., 2016). PCR amplicons for TYLCV were obtained from the six symptomatic tomato samples (Figure 3F).

Viruses always caused major losses in the quantity and quality of tomato crops worldwide and they exibit one of the most significant limiting factors for growers (Letschert et al., 2002; Hassani-Mehraban et al., 2010; Kaye et al., 2011). In Azerbaijan these crops have a high-level incidence of symptoms peculiar to viral infection (Huseynova et al. 2016; Huseynova et al., 2017; Verdin et al., 2018; Desbiez et al., 2018). Regardless of the significance of tomato crops in Azerbaijan, in previous studies only a limited number of samples from a few areas were tested for viruses, but their occurance and distribution in the major tomato grown regions were not estimated. This is the first report of an extensive survey using serological and molecular diagnostic procedures to identify the most important viruses of tomato crops and determine their incidence in the southern Azerbaijan. In the three years of the survey, symptoms such as mosaic, leaf chlorosis, leaf and fruit deformation were found in all tomato fields examined with a prevalence between 25 and 70% of plants. Only 68% of the collected symptomatic samples were found infected with a viruses. The remaining samples may be infected with viruses that have not been examined, or the observed symptoms could be caused by reasons other than a viral infection. CMV was the most prevalent virus in all surveyed tomato growing areas of the Jalilabad, Masally and Lankaran regions. It is also known that CMV causes a big threat to neighboring countries (Gallitelli, 2000). A high frequency of CMV symptoms was detected in tomato plants in Iran, where CMV causes a huge crop loss each year (Zitikaitė et al., 2011; Arafati et al., 2013). Tobamoviruses also have a serious economic impact leading to yield losses in many crops especially in solanaceous crops (Chitra et al., 1999; Chiemsombat et al., 2008). TMV has been reported to cause considerable reduction in Alburz, East Azarbaijan, Fars, Golestan and Tehran provinces, which are the major horticultural crop cultivation regions of Iran (Hu et al., 2012: Alishiri et al., 2013). ToMV is characteristic for eggplants in southern, northern and central Iranian regions (Aghamohammadi et al., 2011). Yazdani-Khameneh (2013) indicated the prevalence of tobamoviruses, especially ToMV, in vegetables in Iran. In recent years, *Pepino mosaic virus* (PepMV) has emerged as one of the fastest growing viruses, which is the most important viral agent in the tomato production worldwide (Hajiabadi et al., 2012). PepMV causes severe symptoms in greenhouse tomato plants in western Mediterranean in Turkey (Sevik et al., 2016). Depending on the host and virus isolate, plant deaths are observed with plant growth disorder, blight, fan leaf, ring stains, softening in fruits and necrosis (He et al., 2012; Koç et al., 2017). Tomato spotted wilt virus (TSWV) is one of the most devastating viruses of sweet pepper and tomato in Samsun province of Turkey (Golnaraghi et al., 2001; Ghotbi et al., 2005; Hajiabadi et al., 2009; Deligoz et al., 2014).

This study reports the natural prevalence of tomato viruses in the southern part of Azerbaijan, which can provide important basic information useful for virus control strategies for tomato growing in our country. The widespread occurrence of viruses showed that these regions of Azerbaijan are very susceptible. Conducting control over the vectors of insects that spread viral diseases should be of fundamental importance for preventing these viruses.

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Azərbaycanda Tomat Bitkisini Yoluxduran Viruslar

İ.M. Hüseynova, N.F. Sultanova, S.T. Mirzəyeva, N.K. Bayramova

AMEA Molekulyar Biologiya və Biotexnologiyalar İnstitutunun Bioadaptasiya laboratoriyası

2015-2017-ci illərin iyun-sentyabr ayları ərzində Azərbaycanın cənub bölgəsində yerləşən əsas tərəvəz çilik rayonlarına fitopatoloji monitorinqlər təşkil olunmuşdur. Cəlilabad, Masallı, Lənkəran rayonlarında yarpaq ayasının burulması, saralması, nekrozu, mozaikası və s. kimi simptomlara malik 263 tomat bitkisi (*Solanum lycopersicum* L.) nümunələri seçilərək toplanmışdır. Toplanmış simptomatik tomat nümunələrinin ilkin olaraq, seroloji (AgriStrip, DAS-ELISA), daha sonra isə molekulyar metodlarla (RT-PZR, PZR) diaqnostikası həyata keçirilmişdir. Seroloji testin nəticələrinə əsasən 179 tomat bitkisi nümunəsi (68%) pozitiv nəticə göstərmişdir. ELİSA testininə əsasən, pozitiv nəticə göstərən DNT və RNT genomlu viruslar, PZR və RT-PZR metodları ilə də yoxlanılmış və nəticələr üst-üstə düşmüşdür. PZR və RT-PZR metodları ilə aparılan amplifikasiya zamanı, universal və spesifik praymer cütləri tətbiq edilmiş və nəticədə gözlənilən 320, 422, 529, 276 və 500 bp ölçüdə amplikonların sintezi baş vermişdir. Yekun olaraq, toplanmış tomat bitkisi nümunələrində *Tomato mosaic virus* (T_oMV), *Tobacco mosaic virus* (TMV), *Tomato etech virus* (TEV), *Tomato spotted wilt virus* (TSWV) və *Cucumber mosaic virus* (CMV) aşkar edilmişdir. Təqdim edilən tədqiqat işi Azərbacanın cənub bölgəsində tomat bitkisində virus infeksiyalarının növ müxtəlifliyini və yayılma areallarını əks etdirir.

Açar sözlər: *Tomat bitkisi, virus xəstəlikləri, Tomato mosaic virus, Tobacco mosaic virus, Tomato etech virus, Tomato spotted wilt virus, Cucumber mosaic virus*

Распространение Вирусных Заболеваний Томата в Азербайджане

И.М. Гусейнова, Н.Ф. Султанова, С.Т. Мирзаева, Н.К. Байрамова

Лаборатория биоадаптации Института молекулярной биологии и биотехнологий НАН Азербайджана

Наблюдения и фитопатологические исследования проводились в период вегетации растений в течение 2015-2917 гг. в самых значимых для овощеводства Азербайджана областях. В трех регионах (Джалилабад, Масаллы, Ленкорань) было собрано 263 подозрительных образца различных сортов томатов (*Solanum lycopersicum* L.) и некоторых некультивируемых растений-хозяев с симптомами листового завитка, карликовости, сужения листьев, некроза, мозаики или пожелтения листьев, с пониженным урожаем и качеством плодов. В зависимости от симптомов, собранные образцы сначала были подвергнуты скринингу с использованием серологических (быстрый одноэтапный анализ AgriStrip, DAS-ELISA), а затем молекулярных (RT-ПЦР, ПЦР) методов, с целью выявления основных вирусов, инфицирующих эти культуры. Согласно результатам серологических тестов, 179 образцов (68%) положительно реагировали с вирусными антителами. Инфекции ДНК и РНК геномных вирусов были проверены полимеразной цепной реакцией (ПЦР) и обратной полимеразной цепной реакцией (ОТ-ПЦР). Тесты ПЦР и ОТ-ПЦР с использованием универсальных или специфических пар праймеров привели к синтезу ожидаемых фрагментов размерами 320, 422, 529, 276 и 500 п.н., соответственно. Полученные результаты, подтвердили наличие *Tomato mosaic virus* (T_oMV), *Tobacco mosaic virus* (TMV), *Tomato etech virus* (TEV), *Tomato spotted wilt virus* (TSWV) və *Cucumber mosaic virus* (CMV) вирусов в образцах томатов. В данном исследовании сообщается о естественной распространенности вирусов томатных растений в южной части Азербайджана.

Ключевые слова: *Томаты, вирусные заболевания, Tomato mosaic virus, Tobacco mosaic virus, Tomato etech virus, Tomato spotted wilt virus, Cucumber mosaic virus*